Inheritance of Decreased Survival on Field Corn of European Corn Borer Cultures Reared Continuously on a Meridic Diet

ARS-NC-45
May 1976

NORTH CENTRAL REGION

AGRICULTURAL RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE

Abstract

European corn borer, *Ostrinia nubilalis* (Hübner), larvae reared continuously on a meridic diet lose their ability to survive on a susceptible inbred line of dent corn. The M3 parent (reared for 3 generations on a meridic diet) had high leaf-feeding damage; the M76 parent (reared for 76 generations on a meridic diet) had low leaf-feeding damage.

The F_1 progeny from M3 $\times$ M76 caused high-intermediate leaf damage. Progeny from the F_1 populations backcrossed to the M3 parent [(M3 $\times$ M76)M3] caused a large amount of leaf damage (as great as that caused by the M3 parent). Progeny from the F_1 populations backcrossed to the M76 parent [(M3 $\times$ M76)M76] caused a small amount of leaf damage (more than that caused by the M76 parent, but much less than that caused by the M3 parent and also less than caused by the F_1's). The major type of gene action is additive. Virulence of the M3 parent, however, shows some dominance.

Indexing words:

Ostrinia nubilalis (Hübner)
Larval survival on meridic diet
Meridic diet: loss of larval virulence on field corn
Inheritance of loss of larval virulence

Inheritance of Decreased Survival on Field Corn of European Corn Borer Cultures Reared Continuously on a Meridic Diet[1]

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Larvae of the European corn borer, *Ostrinia nubilalis* (Hübner),[5] reared on a meridic diet for many generations lose their ability to survive on a susceptible inbred line of dent corn. This trait, as reported by Guthrie and Carter,[6] is genetically controlled. This study determined the type of gene action involved in loss of virulence.

Materials and Methods

The parental corn borer stocks for this study were

(1) A culture reared on a meridic diet for 3 generations (M3). Previous research showed that larvae from cultures reared for 1 to 7 generations on a meridic diet survive on a susceptible inbred line of dent corn (WF9) as well as larvae from a native population (Guthrie, unpublished). Therefore, an M3 culture instead of a native culture was used as one parent.

(2) A culture reared on a meridic diet for 76 generations (M76) was used as the other parent. Previous research showed that larvae reared for at least 34 generations on a meridic diet survive at a low level on WF9.[7]

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[1]Journal Paper No. J-7456 of the Iowa Agriculture and Home Economics Experiment Station. Ames, Project 1923. Part of a dissertation submitted by the first author in part fulfillment of the requirements of the Ph.D. degree.

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[5]Lepidoptera: Pyralidae.

[6]Guthrie, W. D., and S. W. Carter. Backcrossing to increase survival of larvae of a laboratory culture of the European corn borer on field corn. Ann. Ent. Soc. Amer. 65: 108-109. 1972.

[7]Huggans, J. L., and W. D. Guthrie. Influence of egg source on the efficacy of European corn borer larvae. Iowa State J. Sci. 44: 313-353. 1970.

The corn borer larvae were reared in the laboratory by techniques described by Reed and others[8] and Guthrie and others.[9] The M3 culture was reared for the first 2 generations on a plug of diet in 3-dr vials (1 larva/vial). The M76 culture was reared for the first 75 generations on a plug of diet in 3-dr vials (1 larva/vial). Both parental cultures (the last generation) and the F_1 cultures for making backcrosses were reared in plastic dishes containing 930 g of diet; a corrugated cardboard strip (1 in. wide) previously dipped in hot wax was attached to the inner wall of the dish for pupation.[8] Each dish was infested with 40 randomly selected egg masses (about 1000 eggs) and incubated in constant light at 26.7° to 28.3° C and 75 to 80 percent relative humidity.

After 21 days, the corrugated strips containing pupae were removed from the dishes and uncoiled to recover the pupae, which were then transferred individually into jelly cups. A small piece of wet blotting paper was placed in each jelly cup to provide sufficient humidity. When the moths emerged, F_1 and backcross populations were produced by transferring males from one culture and females from another culture to oviposition cages. The parental cultures (M3♀ × M3♂ and M76♀ × M76♂) were made by hanging a corrugated strip containing pupae in an oviposition cage.

The following corn borer crosses were made in 1970:

M3♀ × M3♂	(M3♀ × M76♂)M3♀
M76♀ × M76♂	(M3♀ × M76♂)M3♂
M3♀ × M76♂	(M3♀ × M76♂)M76♀
M76♀ × M3♂	(M3♀ × M76♂)M76♂

Approximately 700 pairs of moths (100 pairs/cage) were used for egg production in all crosses. The methods of handling the eggs, making artificial infestations, and rating the damage to the corn plant leaves were those described by Guthrie and others.[10] [11] An inbred line of dent corn (WF9) susceptible to leaf feeding by the European corn borer was planted in May 1970. The test was arranged as a randomized complete block with 54 replications. Plots were one-row wide five hills/row and three plants/hills (40 in.

[8]Reed, G. L., W. B. Showers, J. L. Huggans, and S. W. Carter. Improved procedure for mass rearing the European corn borer. J. Econ. Ent. 65: 1472-1476. 1972.

[9]Guthrie, W. D., W. A. Russell, and C. W. Jennings. Resistance of maize to second-brood European corn borers. Ann. Corn and Sorghum Res. Conf. 26: 165-179. 1971.

[10]Guthrie, W. D., F. F. Dicke, and C. R. Neiswander. Leaf and sheath feeding resistance to the European corn borer in eight inbred lines of dent corn. Ohio Agr. Exp. Sta. Res. Bul. 860. 38 pp. 1960.

[11]Guthrie, W. D., E. S. Raun, F. F. Dicke, G. R. Pesho, and S. W. Carter. Laboratory production of European corn borer egg masses. Iowa State J. Sci. 40: 65-83. 1965.

between rows and between hills). A guard row was planted between each plot to prevent migration of borer cultures between plots. Nine plants in the midwhorl stage of development in each plot were infested with 4 egg masses (about 100 eggs)/plant in two applications of two masses each made 2 days apart.

The egg masses for the field infestations were selected from masses oviposited during 4 days of peak oviposition. Thus, all egg masses from the 700 pairs of moths in each culture were punched out with a specially designed machine.[11] Masses containing about 25 eggs or more were selected at random from each of the 4 days of production; small masses were discarded. Infestations were accomplished during a 4-day period; plants in replications 1-27 were infested on days 1 and 3 and plants in replications 28-54 were infested on days 2 and 4.

All plots were rated (classes 1-9) for leaf-feeding damage to individual plants 3 weeks after egg hatch. Classes 1-2 had little leaf damage, classes 3-4 had a small amount of damage, classes 5-6 had intermediate damage, and classes 7-9 had a high amount of damage. Plot mean values were used in statistical treatment of the data.

Results and Discussion

From the evaluation of leaf-feeding damage, progeny from the M3 parent (culture 1) had high survival on WF9, progeny from the M76 parent (culture 2) had low survival (table 1).

The F_1 progeny (cultures 3, 4) from M3 × M76 caused high-intermediate damage. The progeny from the F_1 populations backcrossed to the M3 parent [M3 × M76)M3] (cultures 5, 6) caused

TABLE 1.—*Rating classes expressed as percentage of the total number of plants and the means for eight cultures of the European corn borer on WF9, Ankeny, Iowa, 1970*

Culture Number	Culture	Number of plants	Rating[1] for indicated classes 1-2	3-4	5-6	7-9	Mean rating
1	M3♀ × M3♂	467	1.3	7.9	22.3	68.5	7.2
2	M76♀ × M76♂	466	77.9	20.6	1.5	0	1.9
3	M3♀ × M76♂ (F_1[1])	466	9.9	26.2	36.9	27.0	5.1
4	M76♀ × M3♂ (F_1[2])	469	5.5	17.9	30.5	46.1	5.9
5	(M3♀ × M76♂)M3♀	459	3.1	9.2	20.7	67.1	6.9
6	(M3♀ × M76♂)M3♂	467	0	5.4	15.4	79.2	7.7
7	(M3♀ × M76♂)M76♀	466	25.5	41.2	24.9	8.4	3.8
8	(M3♀ × M76♂)M76♂	465	25.8	43.9	22.8	7.5	3.7

[1]Classes 1-2 had little leaf damage, classes 3-4 had a small amount of leaf damage, classes 5-6 had an intermediate degree of leaf damage, and classes 7-9 had a high amount of leaf damage.

TABLE 2.—*Analysis of variance of leaf-feeding damage for eight cultures of the European corn borer on WF9, Ankeny, Iowa, 1970*

Source of variation	Degrees of freedom		Mean square	F-value
Replications	53		1.95	
Treatment	7		223.94	[1]290.83
Reciprocals/F_1		1	71.66	[1]93.06
Additive		1	1396.59	[1]1813.75
Dominance		1	49.66	[1]64.49
Reciprocals/BC		1	6.90	[1]8.96
Other		3	14.26	[1]18.52
Error	371		0.77	
Total	431			

[1]Significant at 1 percent level.

a large amount of leaf damage (as great as that caused by the M3 parent). Progeny from the F_1 populations backcrossed to the M76 parent [(M3 × M76)M76] (cultures 7, 8) caused a small amount of leaf damage (more than that caused by the M76 parent, but much less than caused by the M3 parent and also less than caused by the F_1's).

To determine the type of gene action involved in the loss of virulence of corn borer cultures reared continuously on a meridic diet, we partitioned the treatment sum of squares as follows (table 2):

Reciprocals—Measure the difference of the outcome when an M76 ♀ is used in comparison with an M3 ♀.

Additive—Measures the additive gene effects, that is, the difference between the M3 and M76 parents.

Dominance—Measures any heterosis present from the difference between the mid parent values and F_1's.

Reciprocals/BC—Measure the difference between reciprocals within the backcrosses.

All comparisons (table 2) were highly significant. By using 54 replications, high precision was possible in the F-test; the major type of gene action was additive. Virulence of the M3 parent, however, shows some dominance.

The F_1 (reciprocals) and backcross data (reciprocal/BC) incated a greater paternal than maternal influence of the M3 parent on the progeny (tables 1 and 2). The F_1 progeny from native × M65 also had a greater paternal influence of the native parent.[6] The F_1 progeny from native × M54, however, showed a greater maternal influence on the native parent.[7]

The study showed that one backcross to the M3 parent [(M3 × M76)M3] was sufficient to increase leaf-feeding damage on a susceptible inbred line of dent corn to the same level of damage pro-

duced by the M3 parent. Frequent gene reinforcement from the natural moth population could therefore be used to increase virulence on corn plants from a laboratory corn borer culture. If sufficient numbers of native larvae, however, can be collected each fall, a new culture should be started for field infestations the following season.[9]

Acknowledgment

We thank Mary L. Lodholz and Elva M. Olson for their technical assistance in maintaining the parent corn borer cultures on a meridic diet.

GPO 612-666

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